

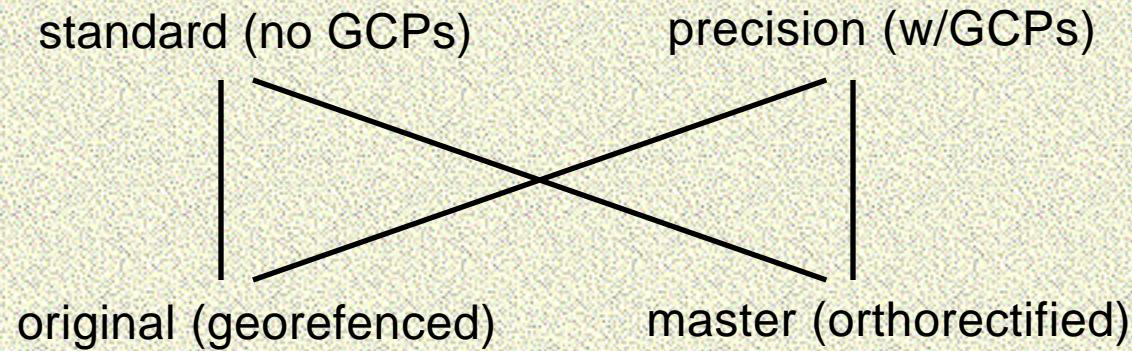


# University of Arizona Spatial Characterization of Ikonos Imagery

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March 19, 2001

# Goal:

Evaluate spatial characteristics of  
Space Imaging Ikonos products for  
NASA Science Data Purchase



# Analysis

Target DN edge profiles

MTF (Modulation Transfer Function)

from target edge profiles (pan)

from 2-D Fourier analysis (MS)

# Data

<b>date</b>	<b>location</b>	<b>Ikonos</b>	<b>underflight</b>	<b>target</b>	<b>products</b>	<b>remarks</b>
July 12, 2000	Tucson	6	color photos	3	NA	clear
July 23, 2000	Tucson	3	6	3	std original prec orig	thin cloud
August 25, 2000	Tucson	3	color IR photos, ATLAS (NASA SSC)	3	std orig* prec orig std master prec master	clear

\* MTFc-on and MTFc-off products

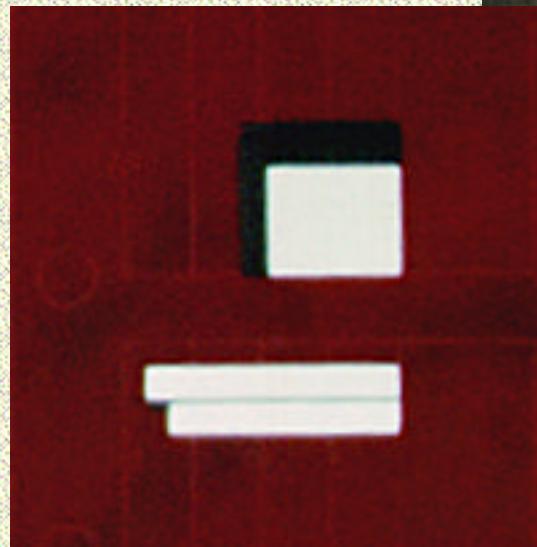
# Ikonos image

8/25/00, Tucson

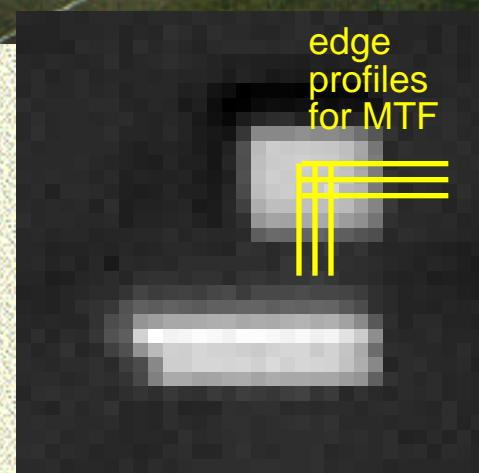
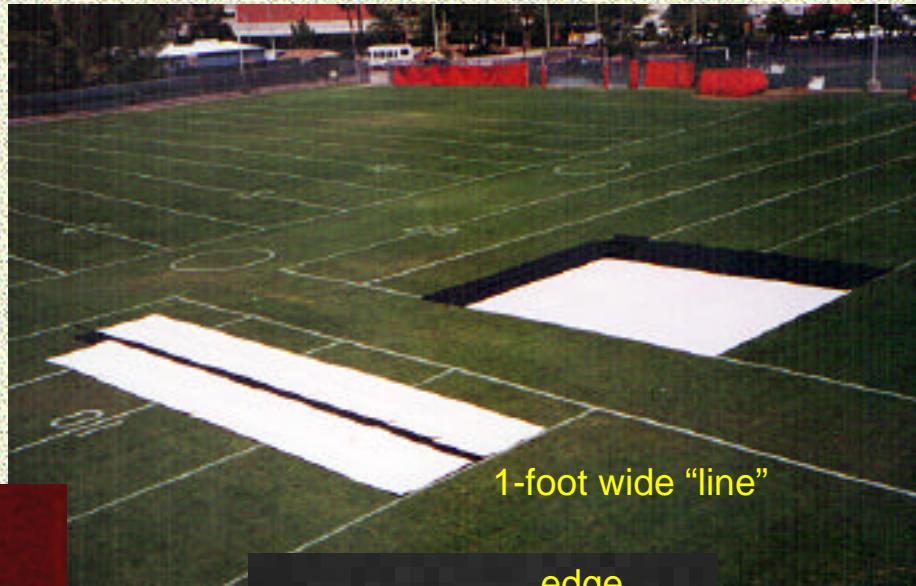


# Target

black & white  
foamcore panels  
white tarps



CIR photo 8/25/00

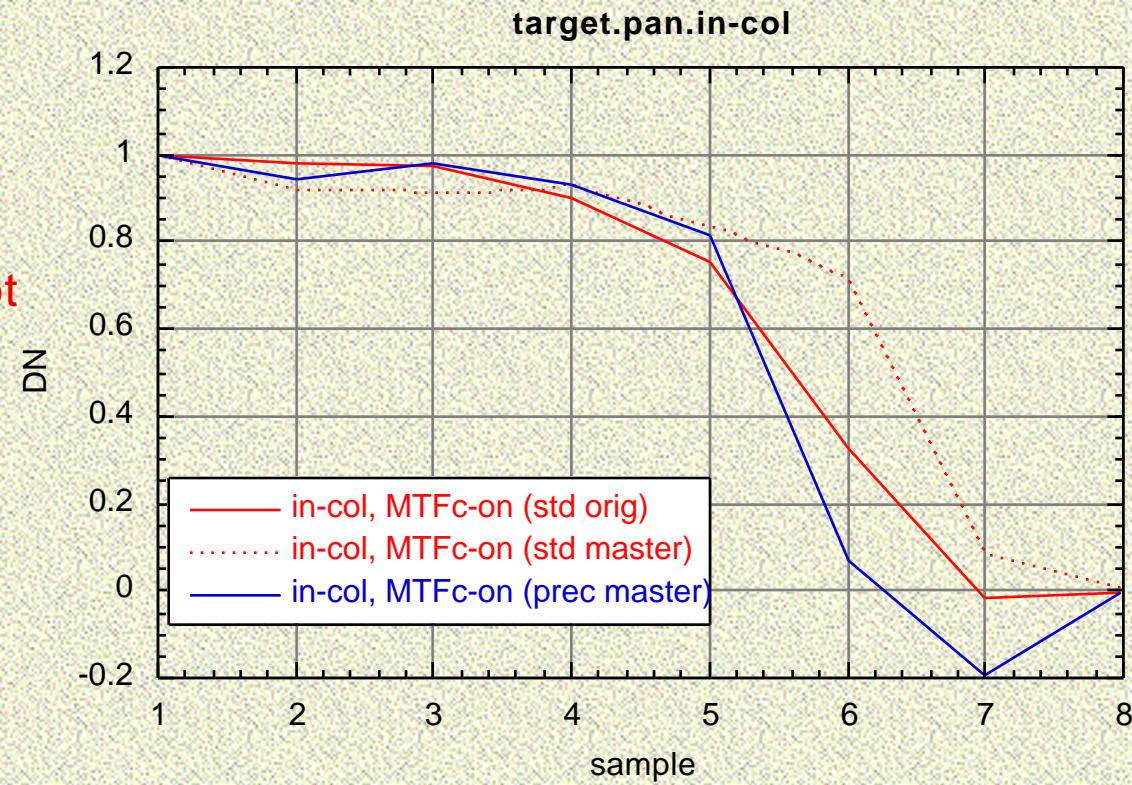


Ikonos pan 8/25/00

# Target Edge Profiles

Product comparison: in-column target profiles

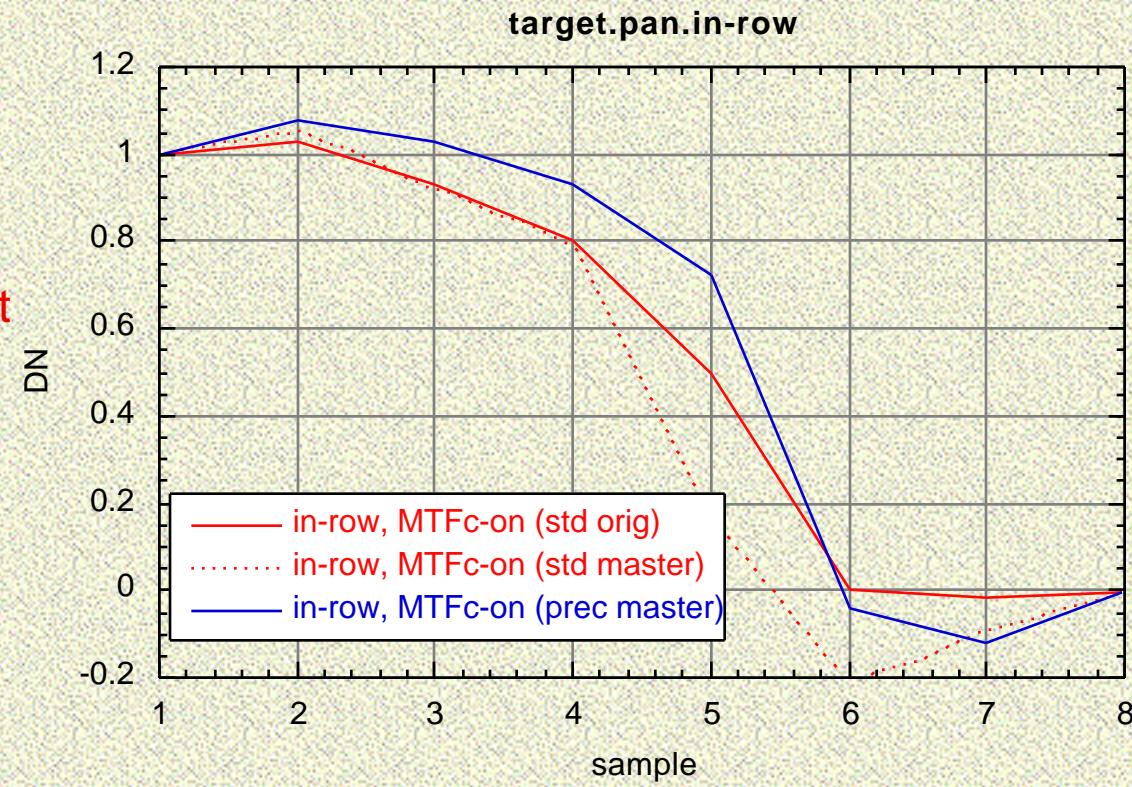
Master  
products  
sharper  
  
Edge  
overshoot



# Target Edge Profiles (2)

Product comparison: in-row profiles

Master  
products  
sharper  
  
Edge  
overshoot

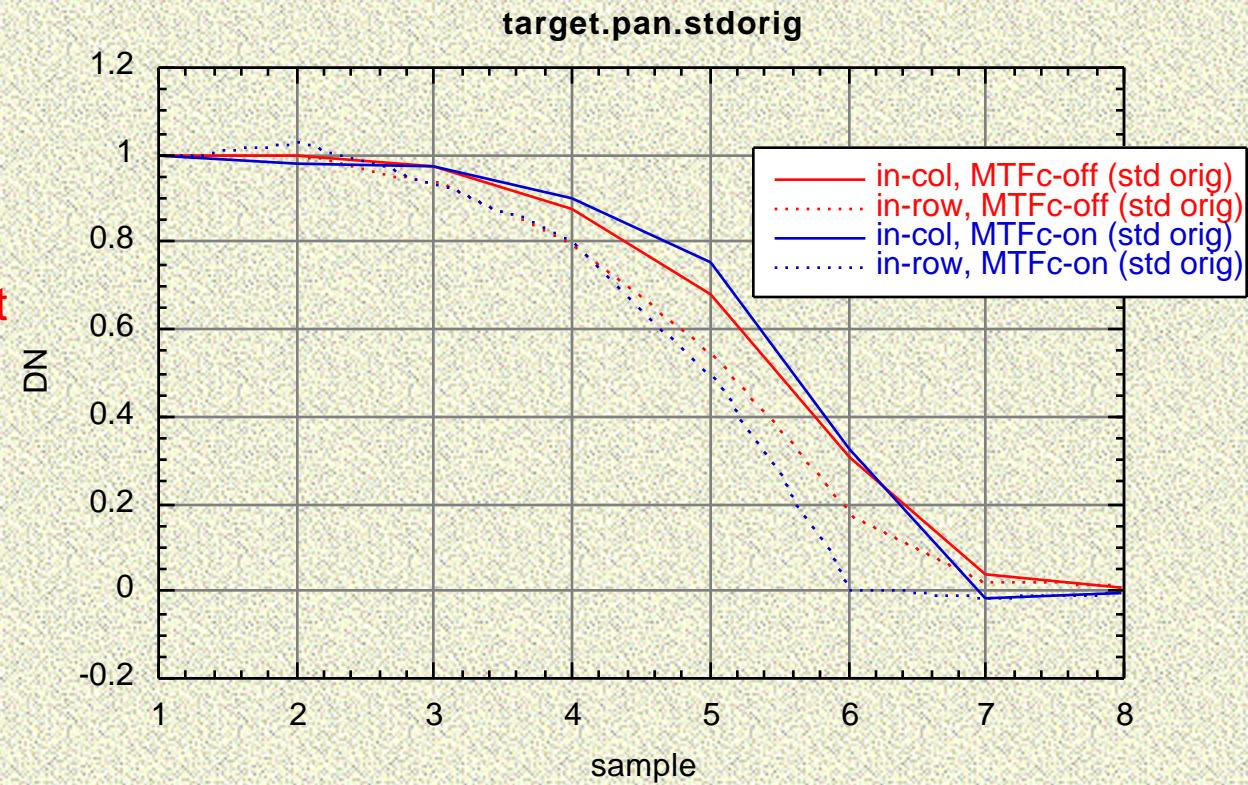


# Target Edge Profiles (3)

## MTFc-off & -on Comparison

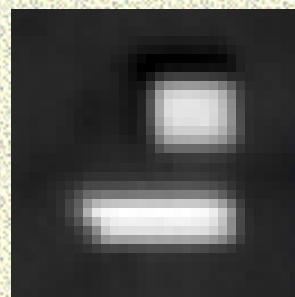
MTFc-on  
sharper

slight  
edge  
overshoot

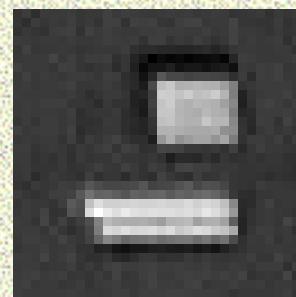


# Target Image Product Comparisons

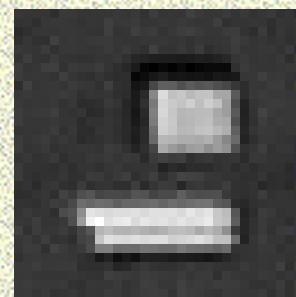
standard original



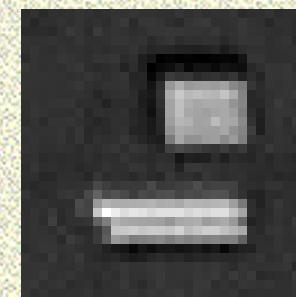
precision original



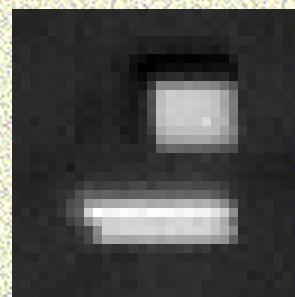
standard master



precision master



MTFc-off



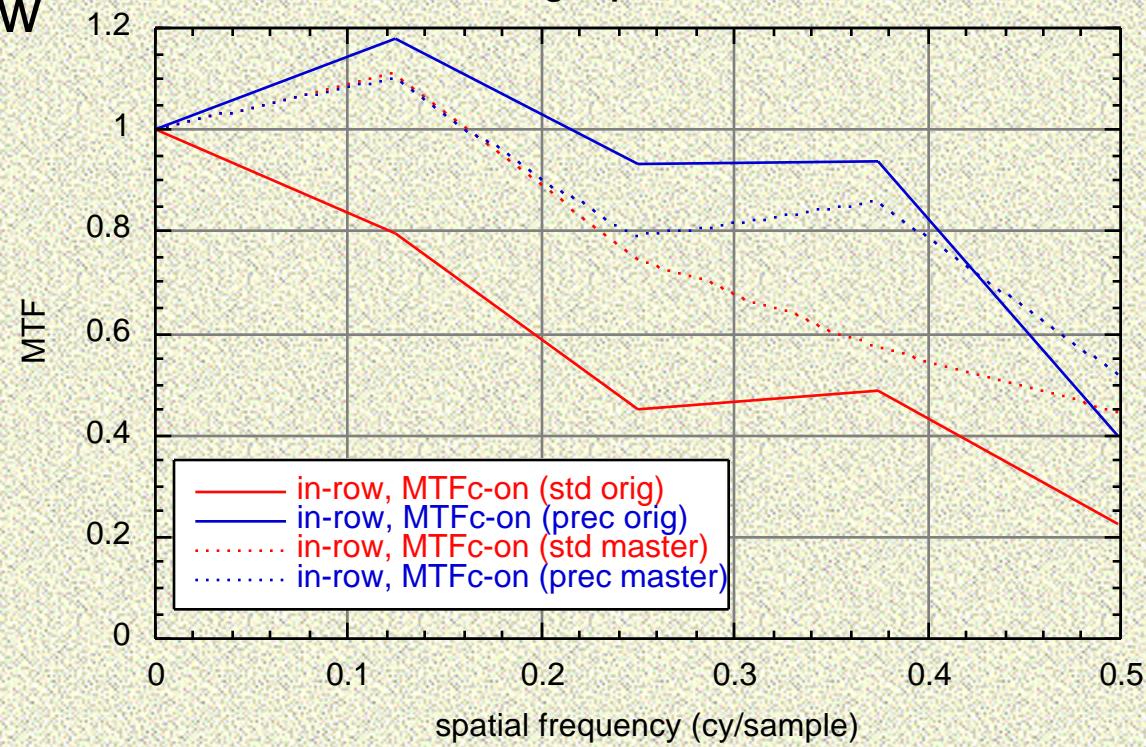
MTFc-on

Precision and Master products sharper, but more edge overshoot

# Compare MTF by product

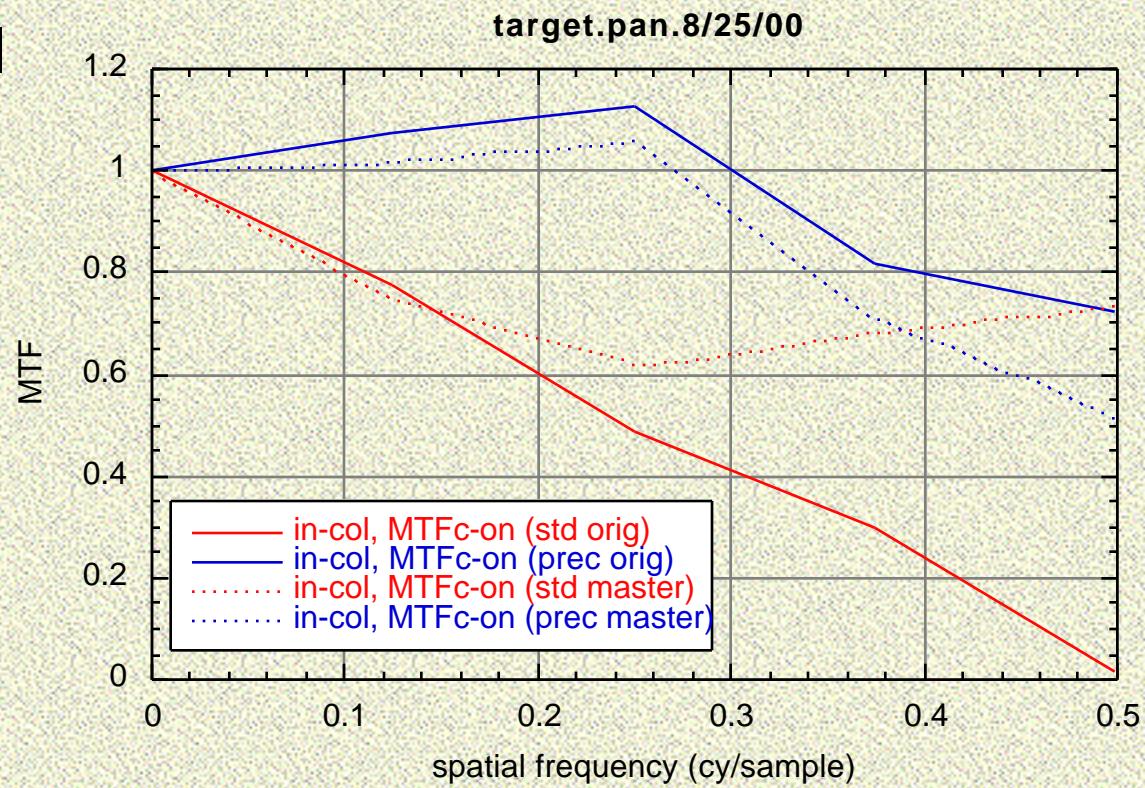
in-row

target.pan.8/25/00

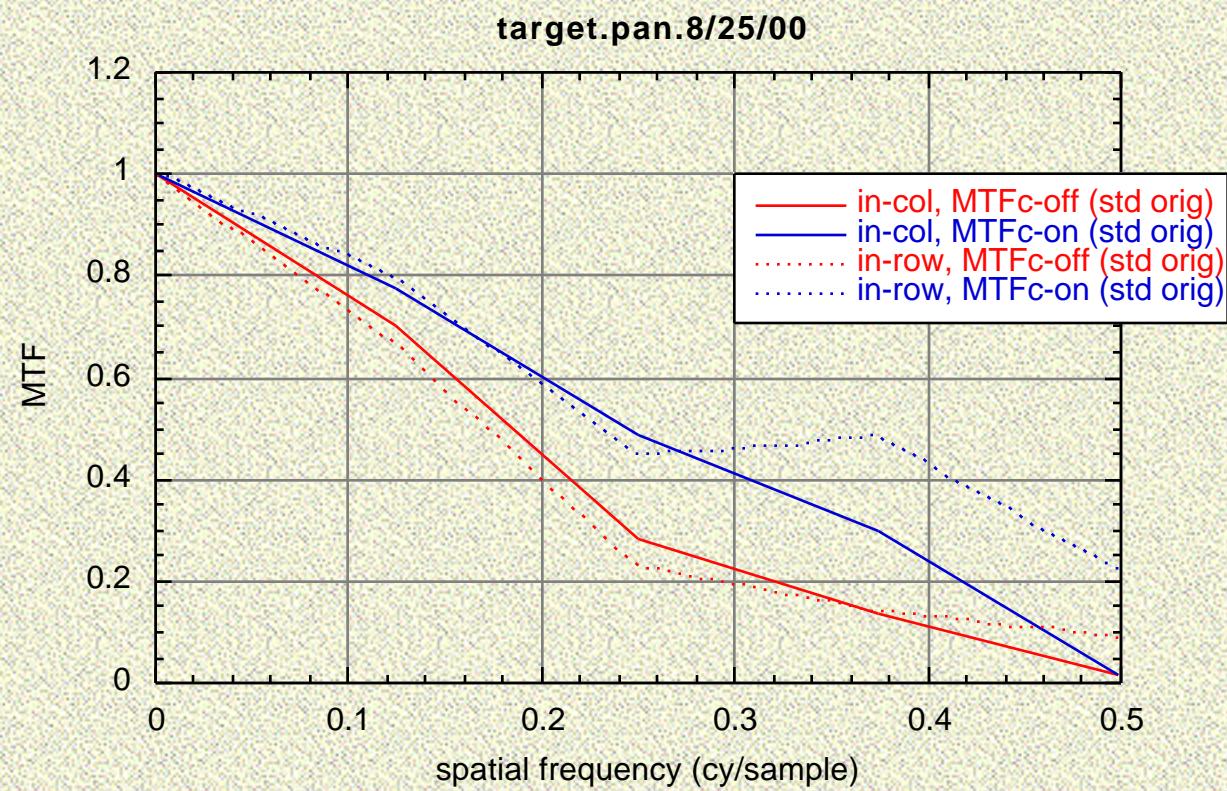


# Compare MTF by product (2)

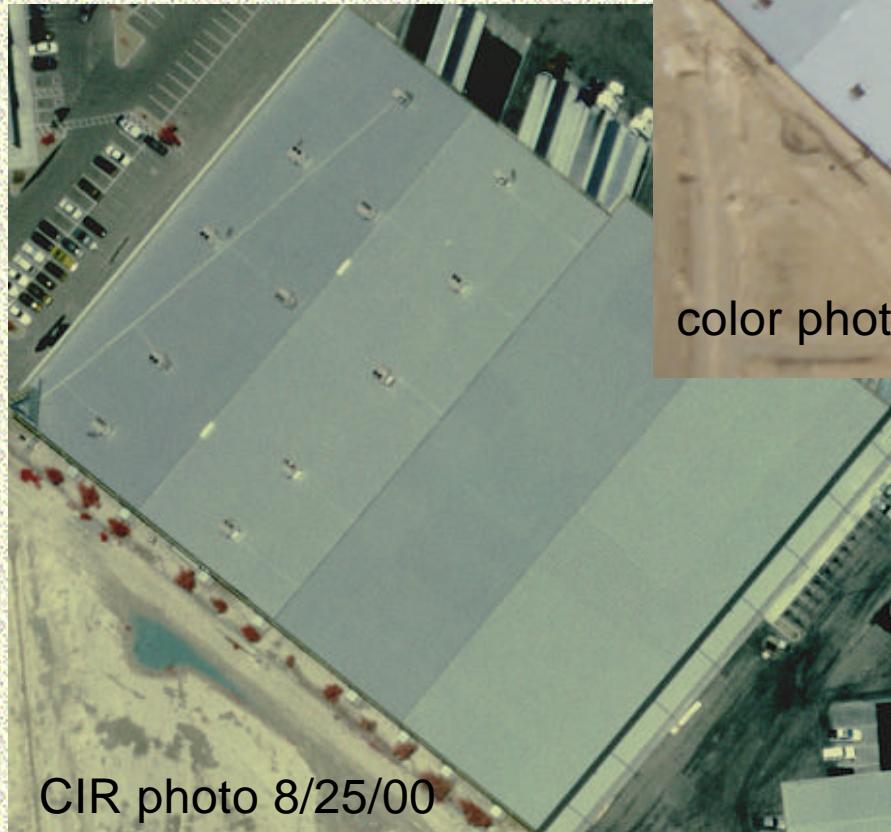
in-col



# Compare MTFc-on/off (STD ORIG)



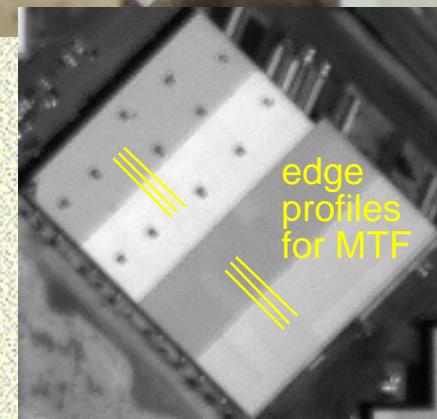
# Warehouse Roof



CIR photo 8/25/00



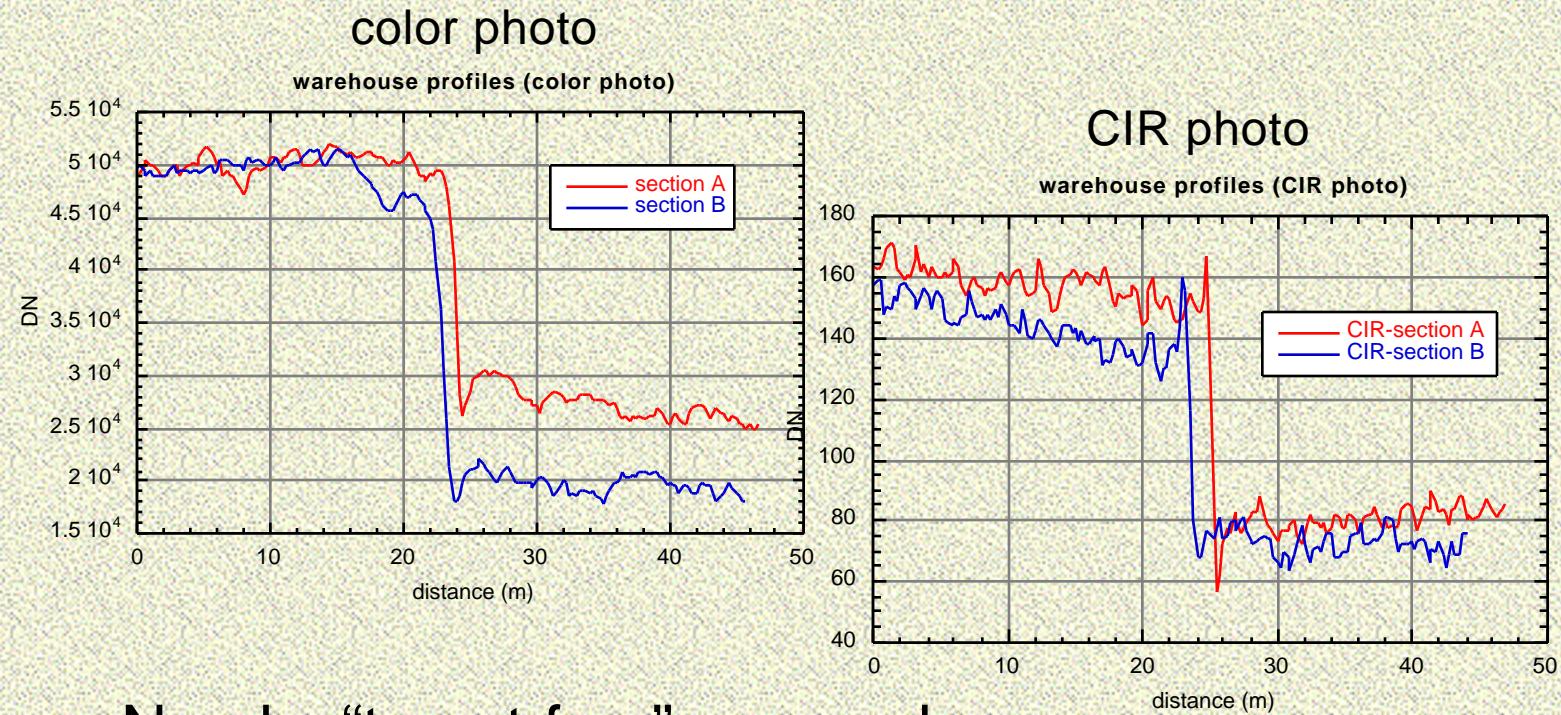
color photo 7/12/00



Ikonos pan 8/25/00

# Validation of Roof Edges

Profiles indicate edges may not be “clean”



Need a “target-free” approach

# 2-D Fourier Transform Approach

Calculate weighted sum of MS bands to approximate pan band

pan vs MS “pan” scattergram



MS band average



spectrally-weighted  
MS band average

## 2-D Fourier Transform Approach (2)

Select co-registered areas from “pan” and pan bands

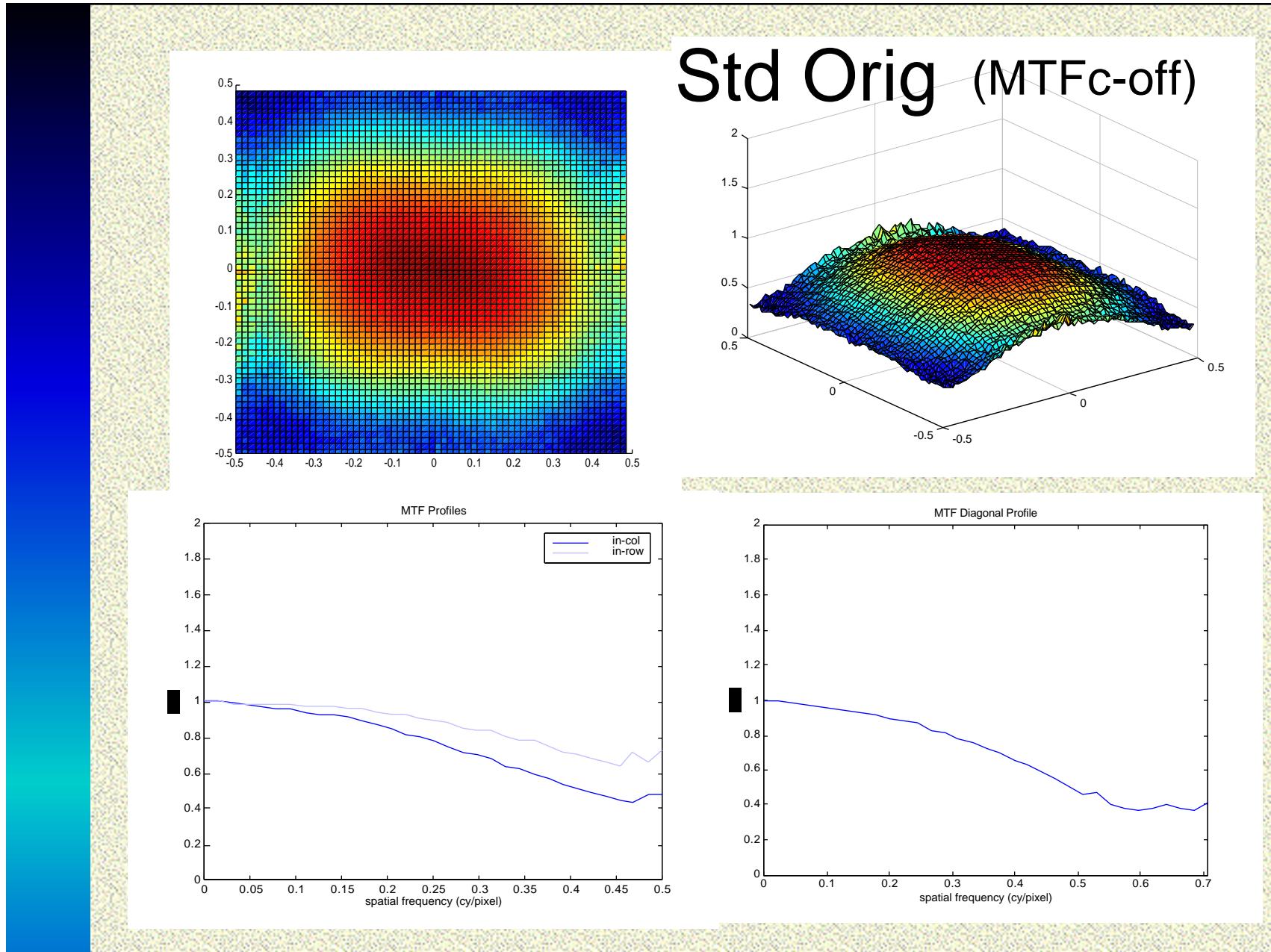
Fourier transform each area

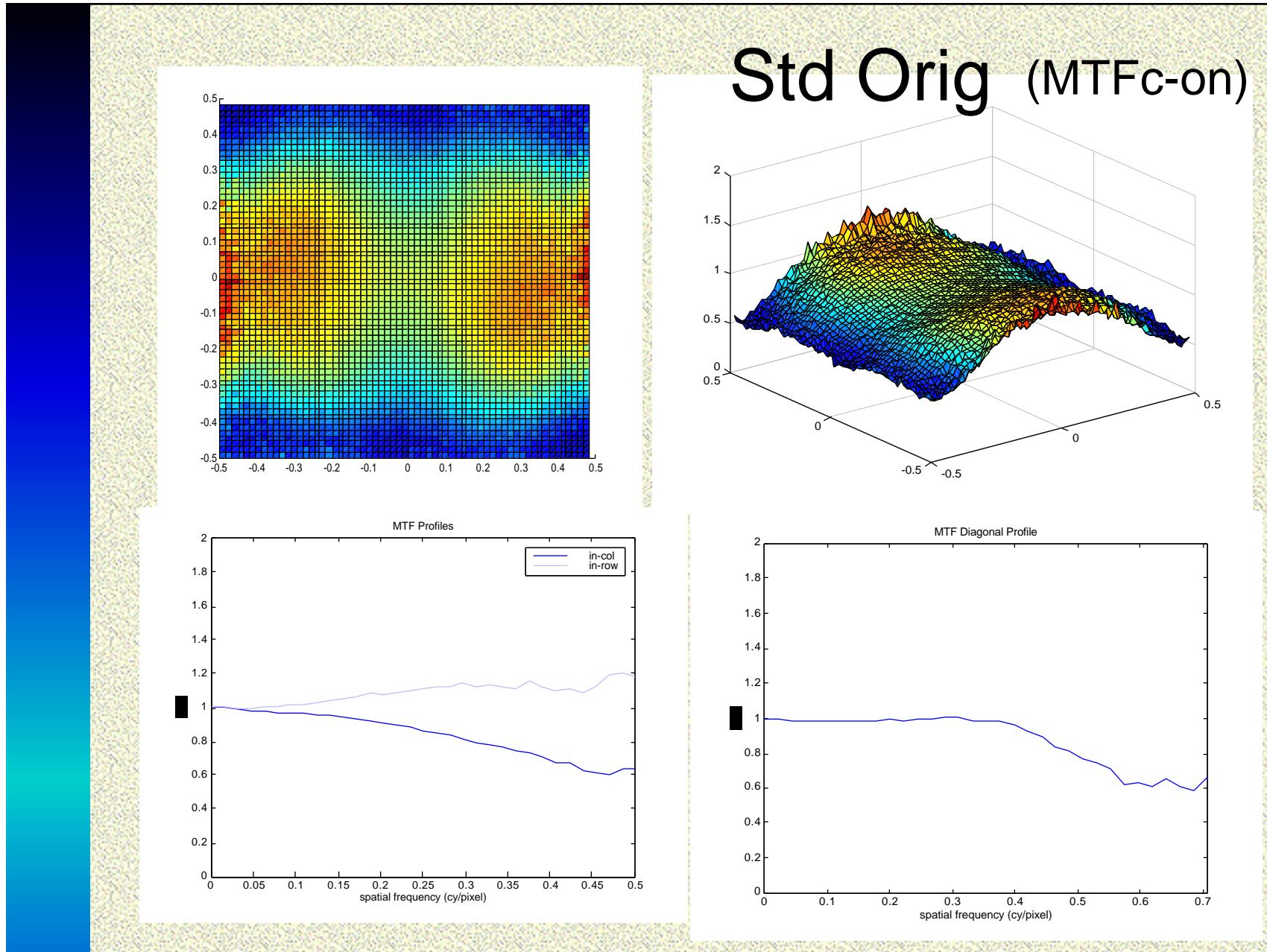
Ratio Fourier amplitudes out to 0.125 cycles/pixel

MS spatial bandwidth = 1/4 pan spatial bandwidth

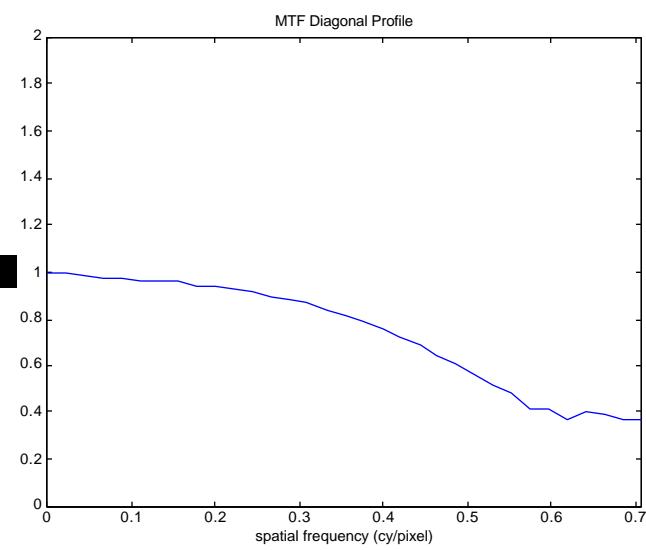
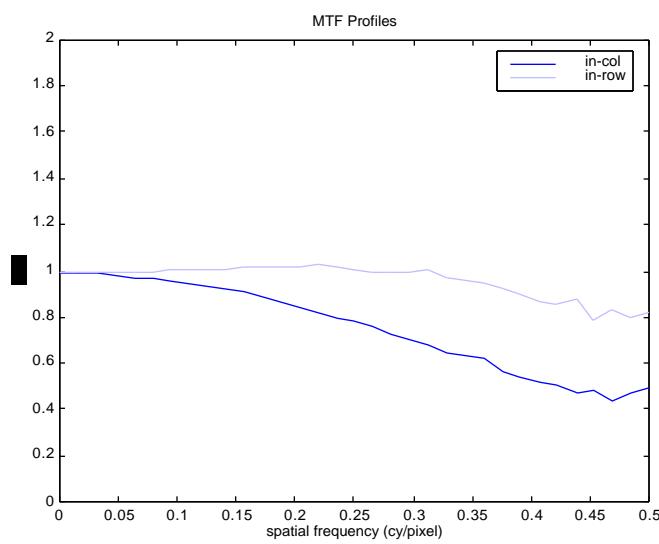
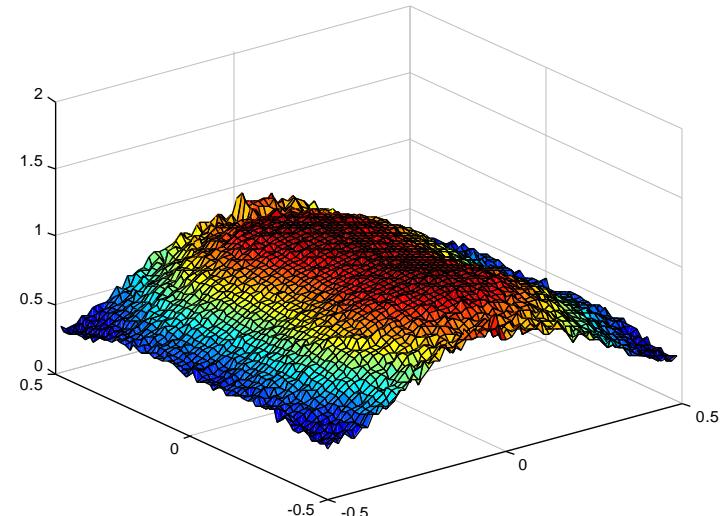
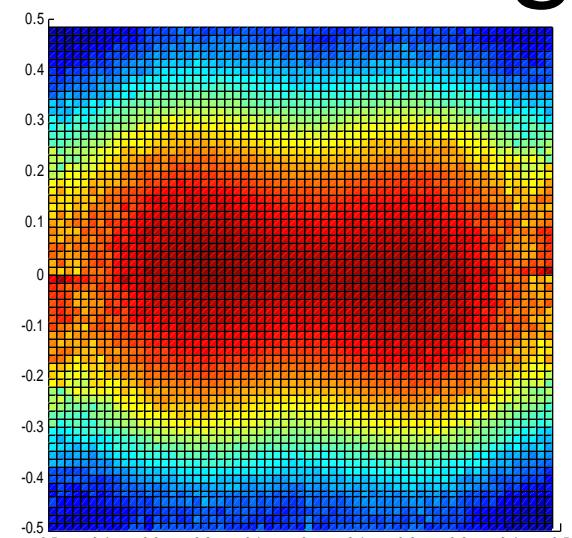
Result is **relative MTF between average MS (“pan”) band and pan band**

Divide MS MTF by respective pan MTF (from target analysis) to obtain “absolute” MTF

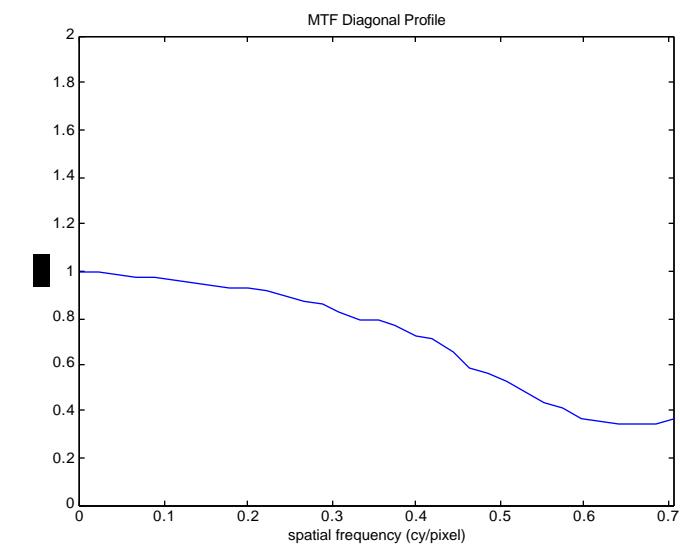
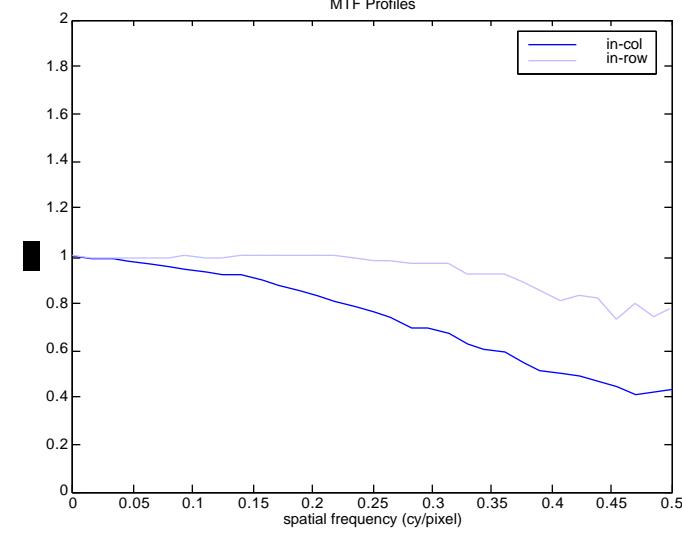
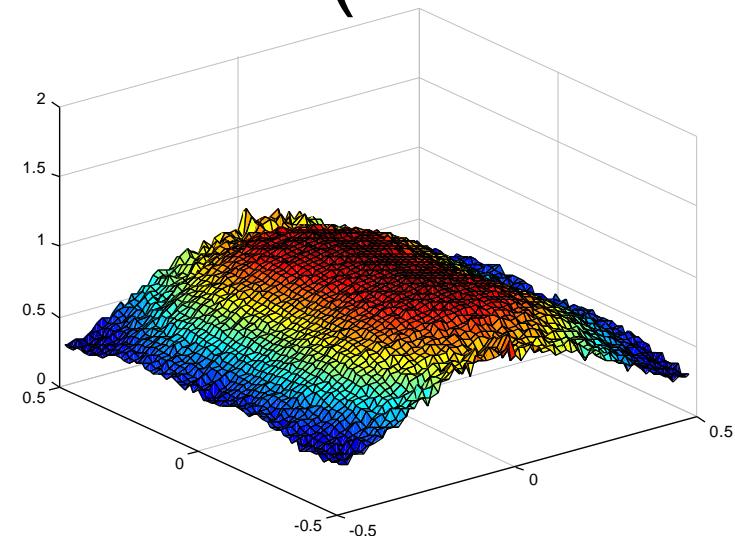
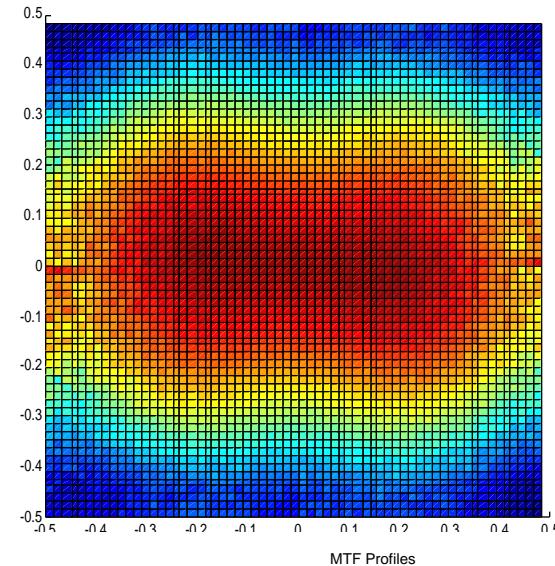




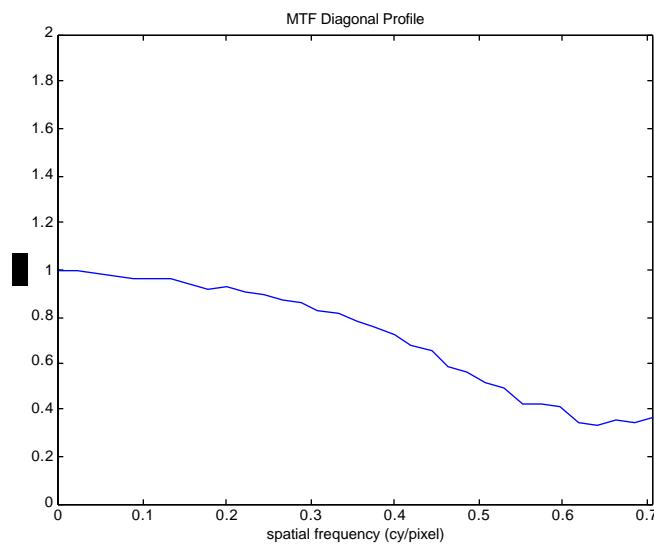
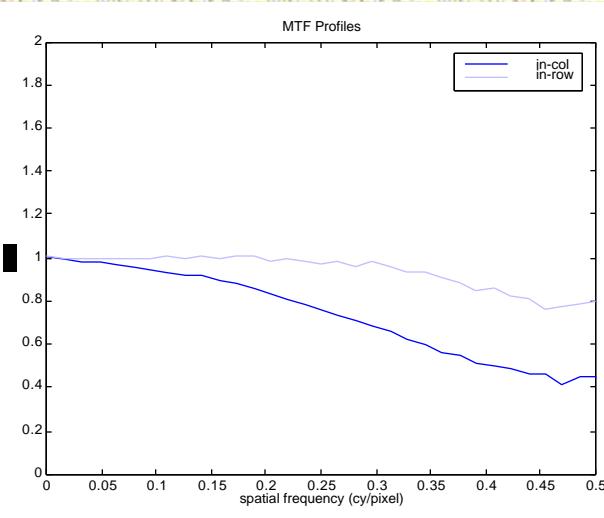
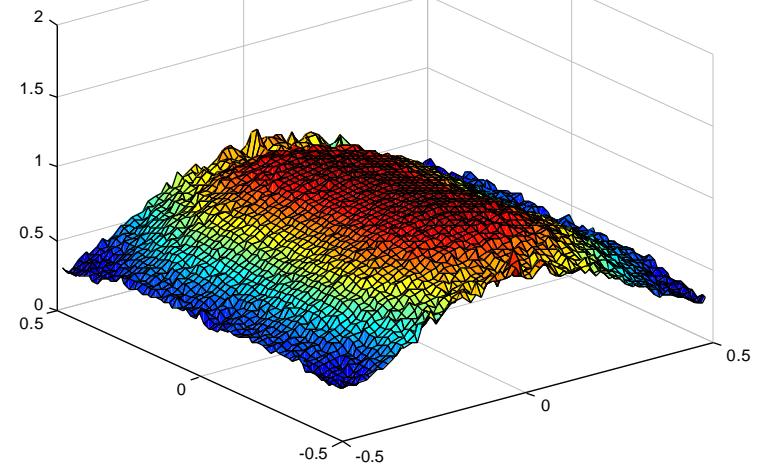
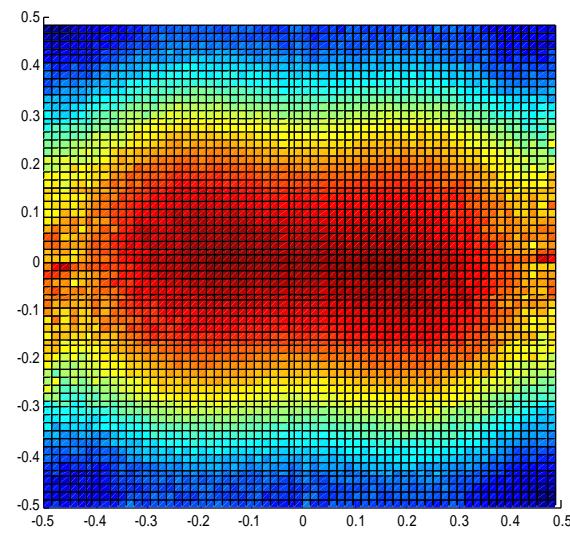
# STD MSTR (MTFc-on)



# PREC MSTR (MTFc-on)



# PREC ORIG (MTFc-on, 7/23/00)

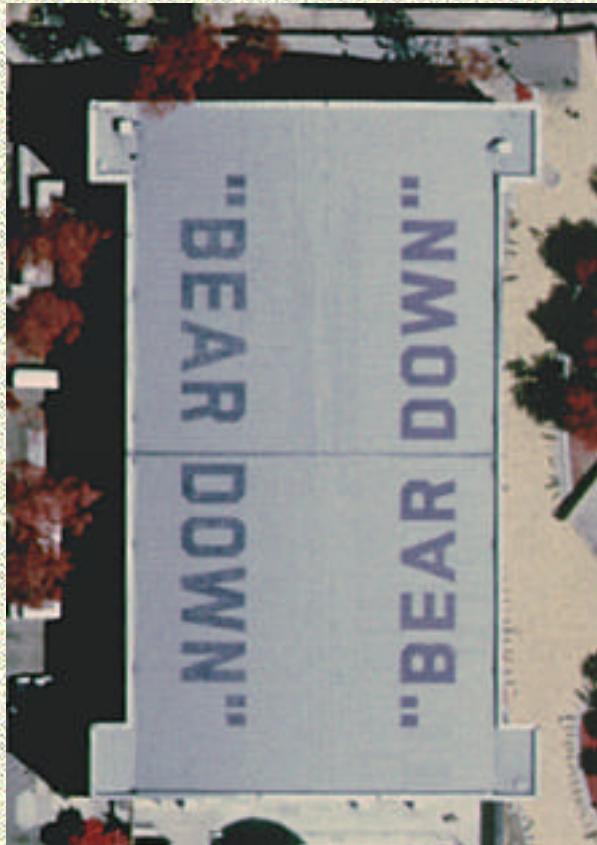


# Summary

Multispectral band MTF @ 0.5 cycles/sample

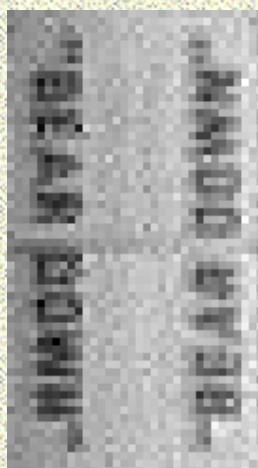
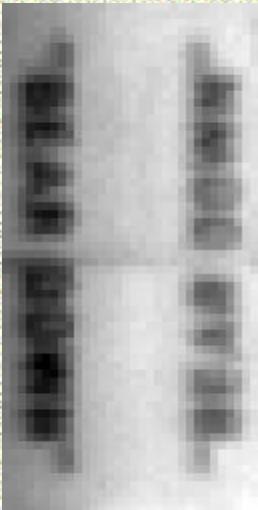
direction	STD ORIG (MTFc-off)	STD ORIG (MTFc-on)	STD MSTR (MTFc-on)	PREC MSTR (MTFc-on)	PREC ORIG (MTFc-on)
in-col relative to pan	0.48	0.62	0.48	0.43	0.44
in-row relative to pan	0.72	1.2	0.8	0.8	0.8
in-col absolute	0.34	0.48	0.36	0.44	0.47
in-row absolute	0.47	0.96	0.88	0.88	0.94

# The Eye Chart



CIR photo, 8/25/00

PREC  
ORIG  
(MTFc-on)



STD ORIG  
(MTFc-on)

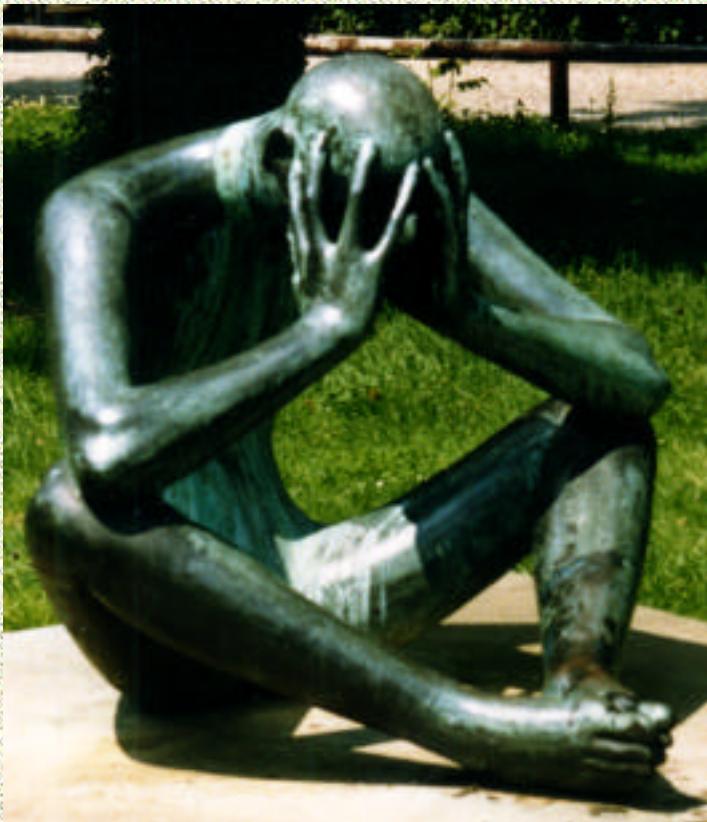


STD  
MSTR  
(MTFc-on)



PREC  
MSTR  
(MTFc-on)

# So, what do we make of all this?



MTFc improves image sharpness,  
without serious DN overshoot

Precision and Master products  
appear to have additional  
“sharpening”, causing 10-20% DN  
overshoot at high contrast edges

MS bands have asymmetry in  
MTF, lower in-col than in-row,  
even with MTFc